It was natural to suppose that the iron vapour producing the cooler lines was higher up than that responsible for the enhanced line at 4924·1. Hence a crucial observation was planned for the eclipse of 1882. If the vapour were higher it should be dimmer, and its lines should, if seen at all, be seen long and faint very near the beginning of totality, while the hotter line, being produced by vapours relatively low and at a higher temperature, should be seen short and bright some time before the beginning of totality.

Fig. 12 will show how absolutely the prediction was verified by the event.

J. Norman Lockyer.

(*To be continued.*)

ON LUNAR AND SOLAR PERIODICITIES OF EARTHQUAKES.

THE investigation of small periodical changes is rendered difficult chiefly by the doubt which so often exists, whether the results obtained by the ordinary methods are due to accident or prove some real periodically acting cause. Attention need only be drawn to the many calculations which have been made to trace the sunspot period in terrestrial phenomena, such as rainfall or temperature, to show that widely different conclusions may be drawn from the same evidence according as greater or smaller value is attached to the element of chance. I have been engaged for some time to apply the theory of probability to investigations of this nature, with a view if possible to being able in every instance to assign a definite number to the probability that any periodicity which may be found in the record of some physical phenomenon is of an accidental nature. In a paper recently communicated to the Royal Society, I have applied the results obtained to the periodicities of earthquakes. Mr. Knott (*Proc. Roy. Soc.*, vol. lx. p. 457) has recently published some investigations, conducted with skill and labour, which in his judgment were favourable to the existence of a true lunar influence on earthquakes. The theory of probability, however, does not support that view. The number of earthquakes treated by Mr. Knott is 7427, and Fourier's series is applied to determine the amplitudes of the changes which have periods coincident with the lunar day, the half-day and the third or fourth part of a lunar day. The method employed would always give some results whether a true periodicity existed or not, and I have calculated what the average amplitudes would be if earthquakes were distributed quite at random. These amplitudes depend, of course, on the number of events taken into the calculation, and are found to vary inversely as the square root of that number. The following table will show how the amplitudes found by Mr. Knott compare with those calculated by the theory of probability. C_1 in the table refers to the lunar day, while C_2, C_3 and C_4 refer to its submultiples.

Coefficients	C_1	C_2	C_3	C_4
Expectancy for the coefficients	19·3	15·7	10·6	5·2
By the theory of probability...	10·3	17·9	10·9	3·97

As it may further be shown that cases will frequently occur where the amplitudes found are equal to twice the expectancy, the table may be considered as conclusive that if a lunar effect exists, it must be so small that it is quite hidden by accidental effects. For the present, at any rate, the evidence is against such a lunar influence. A discussion of the periods, coincident with the lunar months, leads to the same conclusion.

It is otherwise with the annual and daily periods, which have recently been discussed by Mr. Davison. Here the amplitudes found are decidedly too large to be due to accident; and we may therefore say, with a degree of probability amounting practically to certainty, that there is a yearly period giving a maximum of earthquakes in December, and a daily period giving a maximum some time between ten o'clock in the morning and noon.

Arthur Schuster.

NOTES.

A small committee has been appointed by the Treasury "to consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards of measurement, and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes, and to report whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost." The following will be the members of the committee:—The Lord Rayleigh, F.R.S. (chairman), Sir Courtenay Boyle, K.C.B., Sir Andrew Noble, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Prof. W. C. Roberts-Austen, C.B., F.R.S., Mr. Robert Chalmers, of the Treasury, Prof. A. W. Rücker, F.R.S., Mr. Alexander Siemens, Dr. T. E. Thorpe, F.R.S.

At a meeting of the Royal College of Physicians of London, on Thursday last, the College, on the recommendation of the Council, awarded the Moxon gold medal to Sir Samuel Wilks, F.R.S., the President of the College, for having especially distinguished himself by observation and research in clinical medicine, and the Baly medal to Prof. Schäfer, F.R.S., for having especially distinguished himself in the science of physiology. The Harveian oration will be delivered by Sir William Roberts on October 18, St. Luke's Day. Dr. E. Markham Skerritt, of Bristol, will give the Bradshaw lecture on November 4; and Dr. F. Pavy will deliver a special lecture, supplementary to the Croonian lectures, delivered in 1894, on November 11. The following were announced as lecturers for next year:—Goulstonian lectures, Dr. John Rose Bradford; Lumleian lectures, Sir Richard Douglas-Powell; Croonian lectures, Dr. Sidney Martin.

A Parliamentary paper has just been issued giving an additional Civil Service Estimate, amounting to 10,000*l.*, for Art and Science buildings of Great Britain. The total original net estimate for 1897–98 was 26,000*l.*, and this has been increased to 36,000*l.* The British Museum and the Science and Art Department buildings receive 5000*l.* each for new works, alterations, and additions. The increased grant to the Science and Art Department is on account of the cost of carrying out certain urgent works and services at South Kensington, designed to give effect to the recommendations made in the first report from the Select Committee on the Museums of the Department. It is proposed to remove the more dangerous buildings on the east side of Exhibition Road (including the "boilers" and the electric lighting plant), to displace the occupants of the official residences, and reconstruct the entrance to the galleries on the west side of Exhibition Road.

The Weights and Measures Bill (Metric System), the scope of which has already been described (p. 275), was read a third time and passed in the House of Lords on Friday last.

We notice with regret that the Hon. Ralph Abercromby, who did so much for the advancement of meteorological science, died at Sydney, New South Wales, on June 21, at fifty-four years of age.

IT is announced in *Die Natur* that Prof. Rudolf Leuckart, the Nestor of German zoologists, has been made a knight of the Order pour le mérite in science and art by the German Emperor. The same distinction has been conferred upon Prof. Karl Neumann, professor of mathematics at Leipzig.

MR. S. P. LANGLEY, Secretary of the Smithsonian Institution, was present at the meeting of the Paris Academy of Sciences on Monday. In the course of a few remarks upon his experiments in mechanical flight, which he made at the invitation of the President, Mr. Langley said he had greatly enlarged the distance which his aeroplanes would run, without much altering his apparatus. He will shortly publish a detailed account of all he has done upon the subject.

WHAT is believed to be the largest Land Tortoise now living in the world has been lately deposited in the Zoological Society's Gardens by Mr. Walter Rothschild. It is about 4 feet 7 inches in total length, and 2 feet 10 inches in breadth, and weighs about 5 cwt. As regards weight, however, the animal is in poor condition and will probably "put on flesh" when carefully fed. This tortoise belongs to the species called *Testudo daudini* by Duméril and Bibron, which is figured on the fifth plate in Dr. Günther's well-known memoir on Gigantic Land Tortoises. It was originally brought from the Aldabra Islands in the Indian Ocean, though it is said to have been kept elsewhere in captivity for the last 150 years.

THE King of Siam, who arrived in this country on Friday last, paid a visit to the Kew Gardens on Sunday morning, his son, Lord Harris, and several members of the Royal suite accompanying him. The party was received by Mr. Thiselton-Dyer, and afterwards spent some time in the inspection of the various houses and conservatories. His Majesty throughout displayed the keenest interest in the ferns, orchids, and rich variety of Oriental and tropical plants. Many of these he recognised and admired, and noted from time to time that rare specimens of other places were in his own country grown in the open air. He compared the vast and varied collection of Kew with the famous gardens at Buitenzorg, in Java, with which he is familiar, and told Mr. Thiselton-Dyer that his visit was only a preliminary one, and that he should look forward to another occasion when he might inspect the treasures of Kew at greater leisure. After expressing his thanks to the director the King left the gardens. The King and his son and some members of the suite also paid a visit to Greenwich Observatory on Sunday.

THE annual meeting of the Iron and Steel Institute was opened at Cardiff on Tuesday.

AT a recent meeting of the Council of the Australasian Association for the Advancement of Science, letters were read which had been received from the Royal Society of Tasmania, the Royal Geographical Society (Melbourne branch), and the Medical Society of Queensland, suggesting certain means for permanently recording the services to science of the late Baron von Müller, and, in view of the importance of the subject, it was resolved to defer its consideration till the next meeting. The acceptance of the secretaryship of the Section of Economic Science and Agriculture, by Mr. R. R. Garran, was communicated; also that of Mr. H. C. Kent, of the Section of Engineering and Architecture; and that of Dr. F. Tidswell, of the Section of Sanitary Science and Hygiene. Drs. J. W. Springthorpe (Melbourne), D. Hardie (Queensland), and J. Ashburton Thompson forwarded their acceptances of the office of vice-president of this last Section. On the motion of Mr. G. H. Knibbs, it was resolved that Profs. Liversidge, Threlfall, Haswell, Mr. H. C. Russell, and Mr. Deane be deputed to form a preliminary committee to consider the question of appointing a reception committee to arrange for evening lectures, conversazione, a concert, excursions for scientific and other purposes, visits to works, garden parties, conferences, &c., and for the entertainment of members during the week of session. A list of papers promised was laid on the table, and the Secretary reported that the promises of scientific contributions to the various Sections were coming in most satisfactorily.

FOR some little time past there has been a local agitation in favour of opening Kew Gardens to the public in the mornings of week-days. Two deputations waited upon Mr. Akers-Douglas, First Commissioner of Works and Buildings, on Friday last, to urge the desirability of the earlier opening of the gardens. Mr. Akers-Douglas, however, while promising to give the views of the deputations careful consideration, held out no hope of their request being complied with. He said the *raison d'être* of the existence of Kew Gardens was the valuable scientific work it did, and he could not be expected to do anything in the way of extending the hours during which the gardens were open to the general public if it would interfere with that work. The financial question did not weigh with him at all, for if he were convinced that the interests of science would not suffer by the earlier opening he should endeavour to persuade the Treasury to grant any extra money required. The sole question for consideration was whether the interests of science could be combined with the desire of the people for the earlier opening, and he regretted to say that the scientific men whose opinions he had obtained were entirely opposed to the proposal. From a scientific point of view the experiment had not been a success in Edinburgh, and they had no reason to anticipate any better result at Kew.

THE current number of the *Annales de l'Institut Pasteur* contains two very important communications on the etiology of yellow fever, the one by Dr. Sanarelli of Montevideo, and the other by Dr. Havelburg of Rio de Janeiro. Some months ago Dr. Sanarelli gave a lecture in which he reviewed his researches on this subject, a description of which appeared in our issue of July 15; his present communication is a detailed account, occupying eighty pages and elaborately illustrated, of his investigations, and he purposes to continue their recital in a second memoir at a later stage of his inquiries. Dr. Havelburg has worked quite independently of Sanarelli, and has also succeeded in isolating a micro-organism which he holds responsible for yellow fever. He, moreover, places this microbe in the group of coli and typhoid bacilli, and regards it as a form intermediate between these microbes and those associated with hæmorrhagic septicæmia, to which it also bears some resemblance. Cultures of both Sanarelli's and Havelburg's yellow fever microbes have been forwarded by their respective discoverers to the Pasteur Institute in Paris, and are being there submitted to a careful examination to establish their identity or difference. Havelburg mentions that he was able to immunise a dog against yellow fever infection so that its serum protected guinea-pigs from this disease. He hopes to extend his researches in this direction.

PROF. T. R. FRASER, F.R.S., whose experiments on immunisation against serpents' venom, and the treatment of snake-bite with antivenene, have been fully described in these columns (vol. liii. p. 569, 1896), has made another contribution to this subject. His experiments showed, among other things, that, when introduced into the stomach of an animal, serpents' venom produces no obvious injury, even when the quantity is so large as to be sufficient to kill 1000 animals of the same species and weight if the venom were injected under the skin. An investigation of this remarkable fact has now proved that the cause is to be found in the bile, which has such a decided influence upon serpents' venom that it is sufficient in itself to account for the innocuousness of stomach administration. It is shown that the bile of venomous serpents is able, when mixed with the venom of serpents, to prevent lethal doses of the latter from producing death ; and that the bile is indeed so powerful an agent in doing this, that a quantity actually smaller than the quantity of venom may be sufficient for the purpose. It need scarcely be added that the doses of bile thus shown to be sufficient represent only minute portions of the bile stored in the gall-bladder of a serpent, and that a serpent, therefore, has at its disposal enough of bile to prevent injury from venom introduced into the stomach in quantities many times greater than the minimum lethal dose. The bile of other animals, such as the ox, rabbit, and guinea-pig, also possesses this anti-venomous property, but in a smaller degree than that of venomous serpents. Prof. Fraser has isolated the antidotal constituent from the bile of venomous serpents, and an experiment with this substance not only supplies strong confirmation of the evidence that bile is able to render serpents' venom inert, but also suggests that from bile there may be produced an antidote for snake-poisoning, which, in its antidotal value, is at least equal to the most powerful antivenene or antivenomous serum as yet obtained from the blood of immunised animals.

THE Porthcawl Urban District Council required a water supply ; and to the majority of the members it appeared that a water diviner was the most competent man to inform them how to obtain their desire. A specialist, for whom water had strong attractions, was thereupon engaged, though more than one half of the ratepayers opposed this action, thus showing that they were more enlightened than their elect. However, a total expenditure of about 800*l*. was made in connection with the water supply, and apparently upon the recommendations of the water diviner. Nothing might have been known of this scheme outside Porthcawl but for the inquiry which the Local Government Board holds in the case of such expenditure. As the result of the inquiry, however, the water finder's fees have been disallowed on the ground that they had been illegally paid to a person supposed to be possessed of supernatural powers, and upon whose advice several hundred pounds had been spent, which action involved waste of public money. The whole of the expenditure was therefore disallowed, less 250*l*. allowed as a loan for experimental purposes. The Council has thus to pay dearly for its experience.

THE *Annales* of the Central Meteorological Office of France for 1895 contain a valuable discussion of the rainfall of Western Europe, by M. A. Angot. Next to temperature, rainfall is the most important meteorological element, but owing to the difficulty that the subject presents, it has only been seriously attacked in a few cases, the principal exceptions in Europe being for the British Islands, Russia, and the Iberian Peninsula. The influence of topographical conditions and the varying amount of rainfall make it necessary to deal with a great many stations, and a considerable number of years. It is also essential that the data should be for the same years, otherwise the rainfall of a relatively dry period at one station may be compared with a relatively wet one at another station. M. Angot has discussed the monthly and seasonal values at 275 stations for the thirty years 1861–1890. At many of the stations a longer series was available, but at some it has been necessary to reduce a shorter period to the longer one by use of coefficients. The values are given both in a tabular form and upon charts, and a short discussion for each month explains the principal features of the rainfall. Space will not allow us to enter into any of the interesting details shown by the monthly and seasonal charts. The yearly chart shows that the dryest regions, where the rainfall is less than 20 inches, are few in number and small in extent. Outside the Iberian Peninsula there are only five such regions : the south-east coast of Sweden, two in Bohemia, and two in France. In Spain there are several large areas where the fall does not reach that amount, the minimum value being 11·3 inches at Salamanca. Smaller values are recorded in Russia, but this is outside the area of the charts. The greatest amounts are found in Scotland, Cumberland, the southern slopes of the Alps, and the mountainous region of Upper Austria, where the falls exceed 78 inches.

A CORRESPONDENT sends us an extract from a Melbourne paper, *The Age*, for March 13, on the subject of weather forecasting in Australia, which, in the light of Mr. Eliot's recent article in these columns, is of great interest. The following is a brief summary of the communication in question:—Since Christmas the extraordinary weather that has been experienced in Australia has created more than usual interest in meteorological affairs. There have been three falls of snow in the Victorian Alps within the last three months, and at the time of writing (March) Mounts Bogong and Feathertop were covered with snow to a depth of six feet. Mr. Baracchi stated recently that the bad weather of the last few days was caused by the "backing of the Antarctic depression, which has been arrested in its eastward course by suction at the equator." He may be correct, for he has "carefully, as we have seen, kept the data on which his opinion is founded to himself, but it seems somewhat unusual and unlikely." Mr. Russell, of New South Wales, attributes the cold weather to an extensive high pressure of great energy which has come in almost a direct line from West Australia. The writer of the article previously suggested that a probable cause of the unreasonable weather was the unwonted number of icebergs and ice-fields in the Southern Ocean, for almost every ship that hailed from the Cape passed through hundreds of miles of ice.

IN some years the pack-ice and icebergs from Victoria Land drift in vast quantities more northwards than in others, and the cause of their abundance this year is, according to the U.S. Hydrographic Department, the great volcanic disturbances which have broken up the polar sea and set it adrift. Mr. Russell's explanation is that we owe their presence to the long continuance of southerly and south-westerly winds ; but this explanation does not account for the *cause* of such winds. It is, however, "only reasonable to conclude that there is an intimate association between the cold weather and the icebergs." Usually the air blows over a large expanse of open ocean, which warms it before it approaches the coast of Australia ; but in the present year they were chilled by blowing over vast fields of ice and icebergs. It would be interesting, however, to examine carefully the meteorological observations made on ships during their voyages, and it is suggested that "our meteorologists would act wisely were they to imitate the example of the American authorities, who offer inducements to shipmasters for such information."

MR. THOS. MEEHAN records ("Contributions to the Life-Histories of Plants," xii., *Proc. Acad. N.S. Philadelphia*) a case of cleistogamy in an umbelliferous plant, *Cryptænia canadensis*. This species, like so many others of the same order, produces two kinds of flowers in the same inflorescence. The outer florets are male, and possess showy corollas, whilst the inner flowers are hermaphrodite, possessing both stamens and pistil concealed in a small fugacious corolla. Fertilisation takes place in the unopened buds, and thus the process may be legitimately regarded as one of cleistogamy, although the degeneration of floral structure, usually a concomitant feature, is relatively little apparent. There can exist but little doubt that the (assumed) function of the outer sterile showy florets as serving to attract insect visitors proved to be imperfectly discharged, and that a ruinous situation has only been saved by a recourse to self-fertilisation, which is undergoing evolution along cleistogamic lines.

The U.S. Department of Agriculture, Division of Botany, Washington, has just issued as one of the series of "Contributions from the U.S. National Herbarium," "Notes on the Plants used by the Klamath Indians of Oregon," by F. V. Coville. The author, while engaged in a botanical survey of the plains of south-eastern Oregon in the summer of 1896, spent three days at Fort Klamath and the Klamath Indian Agency, from whence he was enabled to secure information as to the principal plants used by the Klamath Indians. The notes are now issued with a view to their use by others in securing fuller and more varied data about the aboriginal uses of plants by this tribe. The author hopes, when the necessary material has been collected, to prepare a comprehensive paper on the subject. The present list includes a few plants which give suggestions of usefulness in the arts and industries of others besides the Indians, among which may be mentioned the yellow pine-lichen, which produces a beautiful canary-yellow dye; the Rocky mountain flax, which furnishes a strong, fine fibre; and several of the tuberous-rooted perennials of the parsley family, which make palatable and nutritious foods.

We have upon our table the following new editions:—"Elemente der Geologie," by Dr. Hermann Credner (Leipzig: Wilhelm Engelmann.) This is an eighth revised edition of a work which first appeared twenty-five years ago. It is a bulky volume of eight hundred pages, illustrated by more than six hundred woodcuts. As a handbook of general geology the work has found considerable favour in Germany.—"Physikalisches Praktikum," by Eilhard Wiedemann and Hermann Ebert. Third revised and enlarged edition (Brunswick: F. Vieweg and Son.) In this work the principles of physics are described with special reference to physico-chemical methods. The volume should be in the hands of every student of physical chemistry familiar with the German language. It is a book both for physical and chemical laboratories, and it contains a course of practical work which should be completed by every student before he begins the study of chemistry.—Messrs. Macmillan and Co. have published the first volume of the sixth edition, revised and enlarged, of "The Elementary Part of a Treatise on the Dynamics of a System of Rigid Bodies," by Dr. E. J. Routh, F.R.S. The dynamical principles of the subject are given in this first volume, together with the more elementary applications, the more difficult theories and problems being reserved for the second volume. Many additions and improvements have been made in the work.—Messrs. Hodder and Stoughton have published a cheap edition (twenty-fifth thousand) of the late Dr. Drummond's "Lowell Lectures on the Ascent of Man."

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. Fleming; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. G. H. Cheverton; a Wood Brocket (*Cariacus nemorivagus*, ♀) from Buenos Ayres, presented by Mr. C. Passingham; a Purplish Death Adder (*Pseudechis porphyriacus*), a Brown Death Adder (*Diemenia textilis*), a Shielded Death Adder (*Notechis scutatus*) from Australia, presented by Mr. E. H. Bostock; two Grooved Tortoises (*Testudo calcarata*) from South Africa, deposited; a Green-billed Toucan (*Ramphastos discolorus*) from Guiana, purchased; three Bar-tailed Pheasants (*Phasianus reevesi*), three Amherst Pheasants (*Thaumalea amherstiæ*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Periodic Comet D'Arrest.—M. Gustave Leveau publishes in the *Astronomischen Nachrichten* (No. 3434) a more accurate ephemeris for D'Arrest's comet than has yet appeared. It may be mentioned that the comet has not only been observed by Mr. Perrine at the Lick Observatory, but also at the observatories of Algiers and Toulouse. By employing these observations the following ephemeris has been computed.

Ephemeris for Paris Mean Midnight.

1897	α			δ	
	h.	m.	s.	°	′
Aug. 5	3	35	13	+5	43·8
,, 7		39	10		34·4
,, 9		43	0		24·3
,, 11		46	43		13·5
,, 13		50	18		2·0
,, 15		53	46	4	49·9
,, 17	3	57	5	4	37·1

Natal Observatory Report.—Mr. Nevill, the Government Astronomer, in his report to the Colonial Secretary for the year 1896, points out that although he has been able with his small staff to cope with the ordinary routine work of the observatory, there is still a great amount of useful and important work which has accumulated, and which awaits printing and publishing. Among these is a valuable contribution to the theory of the moon, which consists of the reduction of all the observations of the moon to a uniform basis and their comparison with the portion of Hansen's tables, whose theoretical accuracy is undoubted. From the difference between these two results must be determined the approximate value and probable period and character of all the terms of long period and their associated terms of shorter period, which are indicated by the observations and shown by the comparison to be required to be added to the known portion of the complete theory in order to enable it to properly represent the motion of the moon. A second piece of work, which is far advanced, consists of a simple and powerful method of calculating from theory the values of such terms as those mentioned above, and to apply them to the computation of the exact values of all the terms shown to exist by the comparison between theory and observation. It may be mentioned that both these investigations have been in progress for some years, and now that they are so near completion their publication should not be delayed. The report contains a detailed account of all the meteorological observations made at the observatory for the past year, in addition to tables of "mean values" for the past eleven years.

Chronometers.—Those who are specially interested in the performance of chronometers will find Prof. Raoul Gautier's report on the "Concours International de réglage pour chronomètres de poche de haute précision," which was presented last year, a very interesting pamphlet. The object of this competition was to examine in every respect the performance of chronometers sent by standard makers, and to award prizes to those which behaved best under the given conditions. The marks were divided into four groups: 100 points for mean daily error, this must not *exceed* ± 0·75s.; 100 for mean error of position, which must not exceed ± 2·5s.; 100 for error of compensation, which must be under ± 0·20s.; and 50 for "reprise de marche," which was not allowed to exceed 5·00s. Of the 142 chronometers examined 12 exceeded 256·7 points, while 32 obtained over 233·3. The most highly rewarded "series of three chronometers" obtained in the mean 271·5 points, one of these, No. 298,225, having received 284·7 points. For further details regarding the actual errors measured, we must refer the reader to the original pamphlet, where he will find all the required information minutely discussed and tabulated.

New Determination of Precessional Motion.—The *Astronomical Journal* (vol. xvii. No. 21) contains a new determination of the constant of precession which was undertaken by Prof. Simon Newcomb at the request of a conference held in Paris in 1896. This conference was brought together to discuss a report on what was to be considered the best system of fundamental stars to be adopted for international use. Prof. Simon Newcomb was chosen to represent this part of the inquiry, and his work having now been accomplished, he pub-